Nucleus:

- Two parts:
  - Proton → charge = +1.6 E-19 C
    m_p = 1.67E-27 kg = 1.007 amu
  - neutron → charge = ∅ C
    m_n = 1.67E-27 kg = 1.008 amu
- Forces:
  - Strong → works over very short distances ($\sim 10^{-15}$)
    → enough strength to combat elecromagnetic force of repulsion between protons
  - Weak → decay
- At some point, size of nucleus becomes too large and strong nuclear force can't hold nucleus together
  - Decay happens
- Isotope → atom with same number of protons and different number of neutrons

Types of Decay:

- Alpha decay:
  - α-particle is $2p^+$ and $2n^0$
  - Decay equation:

$$ {}^{A}_{Z}P \rightarrow {}^{A-4}_{Z-2}D + {}^{4}_{2}\alpha $$

A = atomic mass ($\#p^+ + \#n^0$)

Z = atomic number ($\#p^+$)

P = parent particle

D = daughter particle

α = alpha particle

- Beta decay:
  - Neutron-to-proton ratio
  - $Z \leq 20$, atoms "want" ratio of $N/Z = \underline{1}$
  - Atom will change neutron to proton or vice versa to get N/Z ratio closer to 1
  - This is called beta (β) decay

- Beta decay continued:
  - Parity → atom "likes" p^+ and n^0 to be in pairs
  - 279 stable nuclei

Z	N	# Stable Nuclei
Even	Even	168
Even	Odd	57
Odd	Even	50
Odd	Odd	4

- Examples:
  - Boron-12

    $p^+ = 5$ $n^0 = 7$

    stable?

    Does $N/Z = 1$? No

    Parity → odd/odd

    NOT Stable

This will β-decay to change $n^0 \rightarrow p^+$. This changes atom to ^{12}C, giving $N/Z = 1$

and parity as even/even

– Example: ^{12}N $p^{+}=7$, $n^{0}=5$

If there are more p^{+} than n^{0}, atom is unstable.

convert p^{+} to n^{0}, giving ^{12}C

– β^{+}-decay:

proton → neutron

$$^{A}_{Z}P \rightarrow {}^{A}_{Z-1}D + e^{+} + \nu$$

↳ neutrino (ν)

↳ positron (e^{+})

– β^{-}-decay: neutron → proton

$$^{A}_{Z}P \rightarrow {}^{A}_{Z+1}D + e^{-} + \nu$$